

Trajectory Generator Design by using B-Spline Curves

Ching-Chang Wong, Chia-Jun Yu, and Szu-Hao Lien

Abstract— In this paper, a trajectory generator by using B-Spline curves is designed for robot manipulators. It can quickly generate smooth curves. Moreover, it needs less memory to store the generated trajectories.

Keywords—Robot Manipulator, Trajectory generator, B-Spline curves.

SYSTEM ARCHITECTURE

In this paper, a trajectory generator by using B-Spline curves is designed to solve the problem of the artificially generated trajectories based on AutoCAD for a robot manipulator moving. The trajectory of the end-effector of a robot manipulator can be generated by using B-Spline functions. The B-Spline curves just utilize a few control points to generate a smooth trajectory and it can arbitrarily change the local shape of the trajectory [1][2]. The function is represented by

$$C(t) = \sum_{i=0}^n N_{i,k}(t) P_i, \quad t_{\min} \leq t < t_{\max}, \quad 2 \leq k \leq (n+1) \quad (1)$$

where $\{P_i\}$ is a set of control points forms a control polygon. $N_{i,k}(t)$ is the i th B-Spline basis function of order k (degree $k-1$) with the knot vector $t=\{t_0, t_1, t_2, \dots, t_l\}$. They are defined recursively as follows:

$$N_{i,1}(t) = \begin{cases} 1 & \text{if } t_i \leq t < t_{i+1} \\ 0 & \text{otherwise} \end{cases} \quad (2)$$

$$N_{i,k}(t) = \frac{(t-t_i)N_{i,k-1}(t)}{t_{i+k-1}-t_i} + \frac{(t_{i+k}-t)N_{i+1,k-1}(t)}{t_{i+k}-t_{i+1}} \quad (3)$$

The trajectory generator by using B-Spline curves is constructed for robot manipulators [3] [4]. First, a software platform used on PC is designed with MATLAB [5] so that the users can add or remove control points to let the curves meet the desired trajectory. One example is shown in Fig. 1.

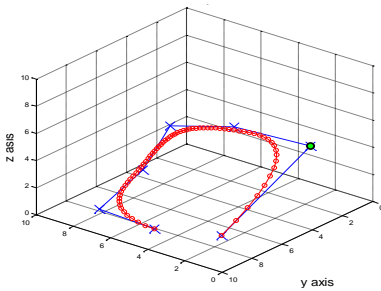


Fig. 1. Trajectory generated by using B-Spline curves.

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Ching-Chang Wong, Chia-Jun Yu, and Szu-Hao Lien are with the Intelligent Control Laboratory, Department of Electrical Engineering, Tamkang University (TKU), New Taipei City 25137, Taiwan (e-mail: iclabee@gmail.com; chiajun.yu@gmail.com; rocky202077@gmail.com)

Then the position information of control points is obtained to be the input data of the trajectory generator of the robot manipulator. It can let the robot manipulator quickly generate a continuous and smooth trajectory. Moreover, it needs less memory to store the generated trajectories.

The trajectory generator by using B-Spline curves is designed. It will be implemented on a six-axis robot manipulator to illustrate that it can quickly generate a continuous and smooth trajectory. The block diagram of a control system structure for a six-axis robot manipulator is shown in Fig. 2. There are two main units: software strategy and hardware control. The control procedures can be described as follows:

- 1) Generate trajectories by using B-Spline functions.
- 2) A position command is sent to the Motion Control card by using PCI interface.
- 3) The control card transforms the command into control signal.
- 4) The control signal is sent to the six-axis servo motor.

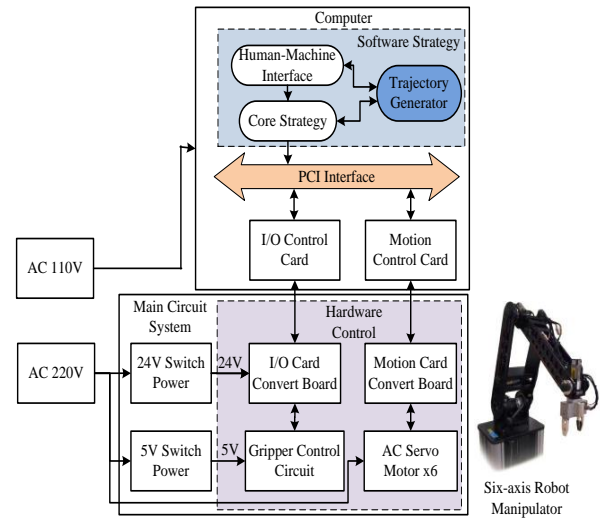


Fig. 2. Block diagram of a control system structure for a six-axis robot manipulator.

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